

ADS-B Conformance Monitoring

An Introductory Approach for Early Benefits

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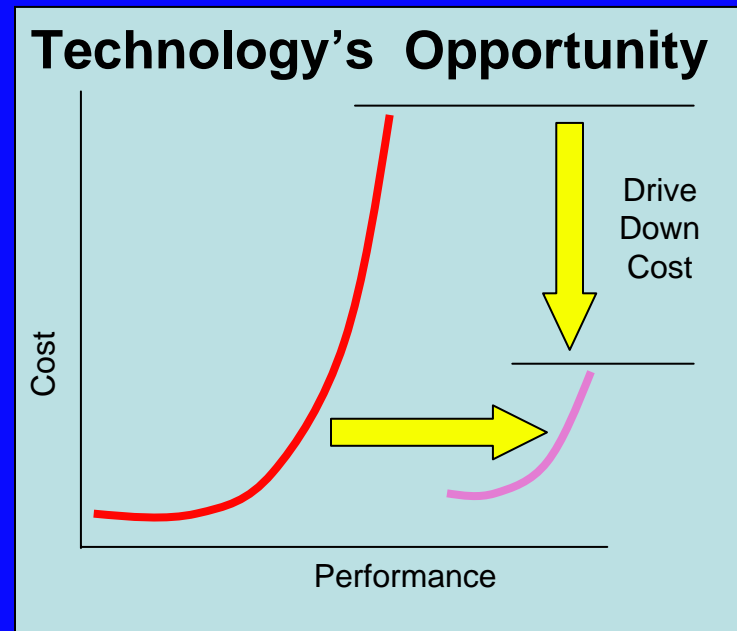
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PROBLEM Statement

- How can early benefits be delivered from ADS-B (Out) while waiting for surveillance use in aircraft separation?
 - Obstacles:
 - Rulemaking in the airspace to require equipage
 - Waiting for 80 % voluntary, then exclude non-equipped from the airspace
 - Surveillance data fusion and automation changes
 - Looking at ADS-B as a method of surveillance instead of a tool for conformance
- How can we get capacity and efficiency with “NowGen”

Making ADS-B Disruptive as Opposed to Just Another Surveillance Capability

**Disruptive technology can
drive a significant increase in
performance while driving cost down**



Target

Continuous Descent Arrivals

- Proven benefits in fuel savings - direct, high-value, and measurable
- Global acceptance of the concepts
 - Obstacles:
 - Works great for ones and twos - needed in mixed equipage high-density traffic
 - Giving clearances consistently - a merging and spacing dilemma for the air navigation service provider

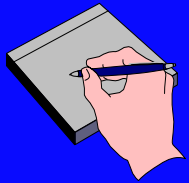
Solution

Conformance Monitoring

- Alerts on existing controller displays
- Rule-based performance
- Penalty for non-conformance goes to the offender - fly-it or lose-it
- Surveillance does not change
- Adds 4 dimensions to RNP concepts
- Increases opportunities for fuel efficient maneuvering as a transition to 4-D trajectory management

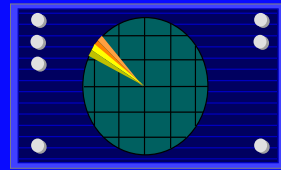
Evolution of ATC/ATM

Past
Procedural
Separation



Estimate
current &
future aircraft
positions

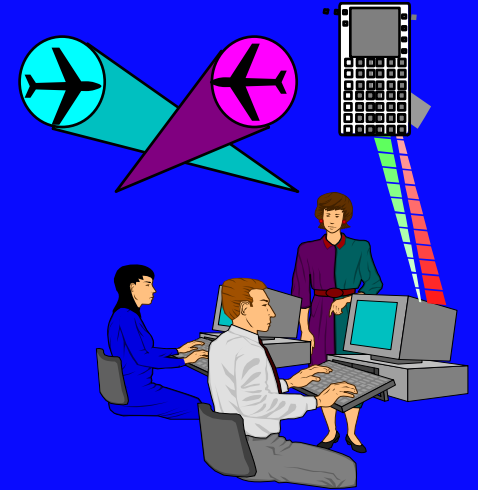
Present
Radar
Separation



Know current &
estimate future
aircraft
position

Conformance
Transition
a
Rule-based
Bridge
within
“NowGen”

Future
4-D Trajectory
Separation



Know
current and
Know future
positions

Intent

Conformance (noun)

- The act of conforming or bringing about accord or compliance
- Compliance with standards, rules or laws
- Behavior in accordance with socially accepted conventions or standards

Conform (verb)

- To correspond in form or character; be similar
- To act or be in accord or agreement; comply
- To act in accordance to current customs or modes

Lateral, Longitudinal, Altitudinal and Temporal Conformance

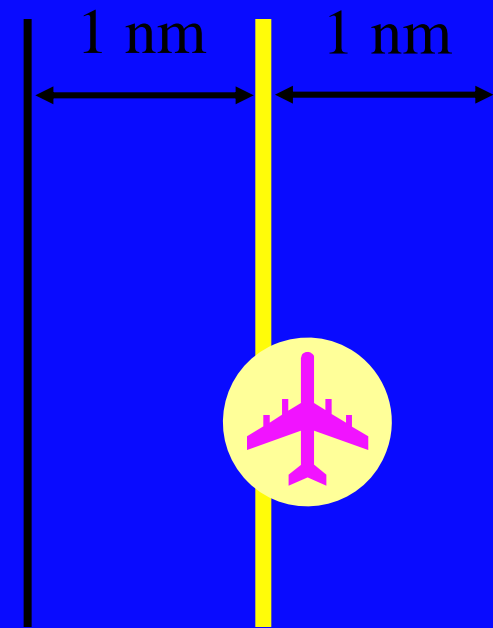
- **Lateral** = Required Navigation Requirement (RNP) displacement from ground track
- **Longitudinal** = Positioning from GPS and eventually other satellite systems (GNSS)
- **Altitudinal** = current altimetry provided by clearance
- **Temporal** = required time of arrival at waypoints

Lessons Learned from RNP

- Significant reduction in communications workload between pilots and controllers
- Increased precision of ground track
- Flyable for both arrivals and departures
- Standard for the future of navigation and positioning
- Available today and at a lower training cost than the current multiple choice approach for navigation

RNP is NAV Containment

- Expressed as nautical miles (nm) and fractions of nautical miles to define precision navigation performance
- RNP 1.0 guarantees the aircraft is within 1 nm of expected flight path with 95 % confidence



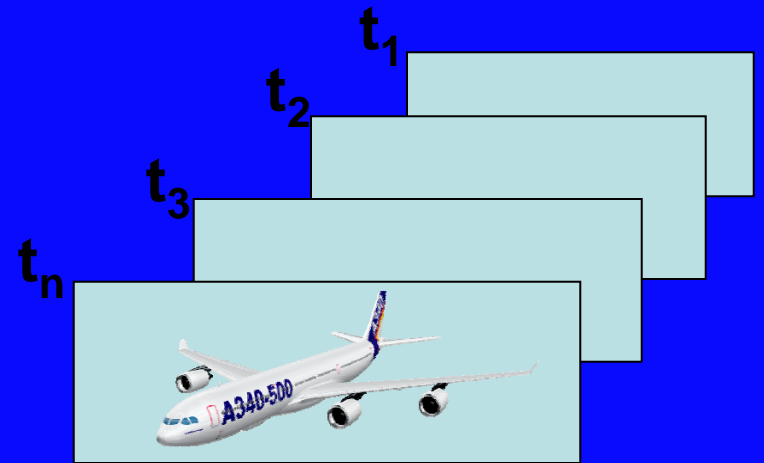
RNP 1.0

RNP is containment and alerting in the cockpit

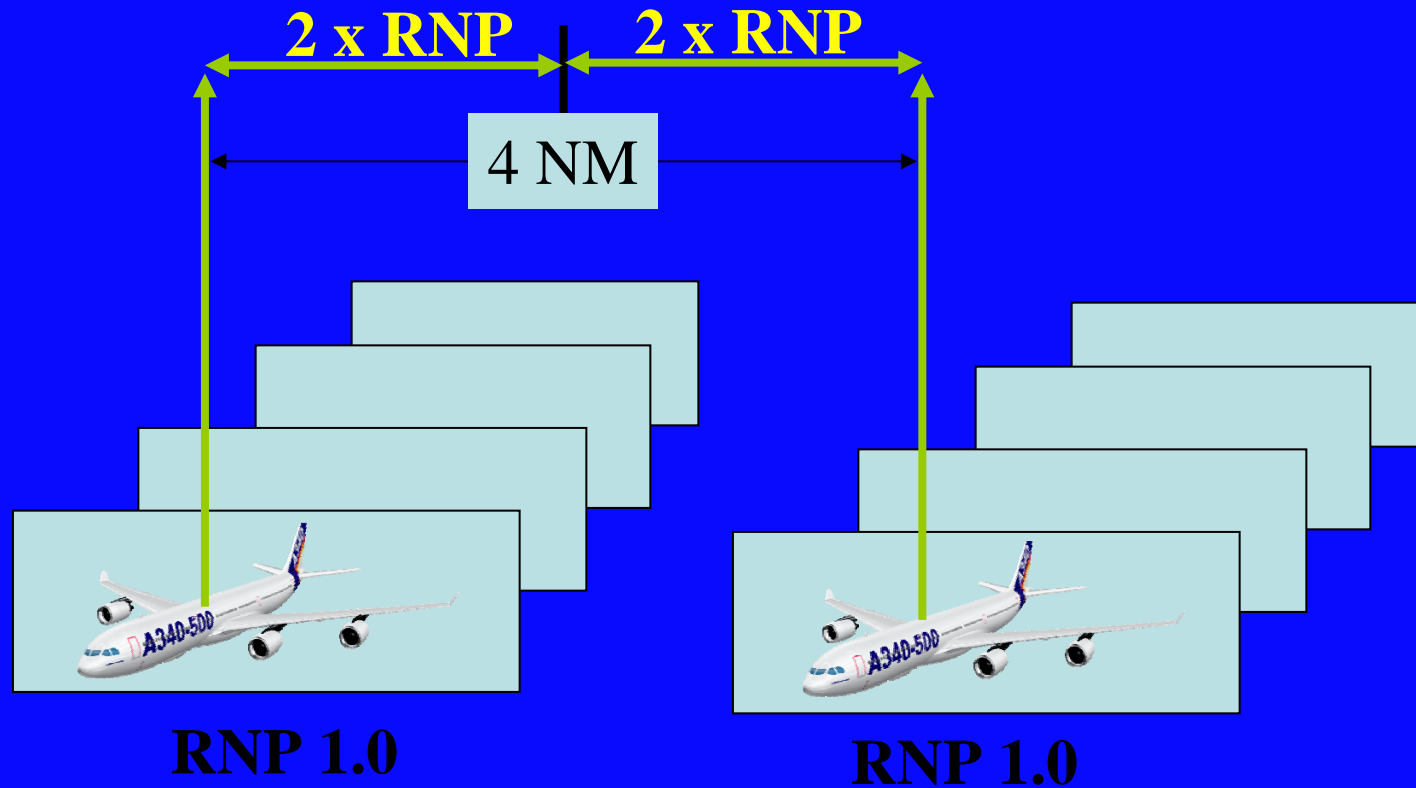
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Single Aircraft RNP Containment

- Two dimensional slices in time (altitude and lateral displacement)
- When time slices are linked together it forms the basis for new approach and departure procedures - but RNP could be so much more

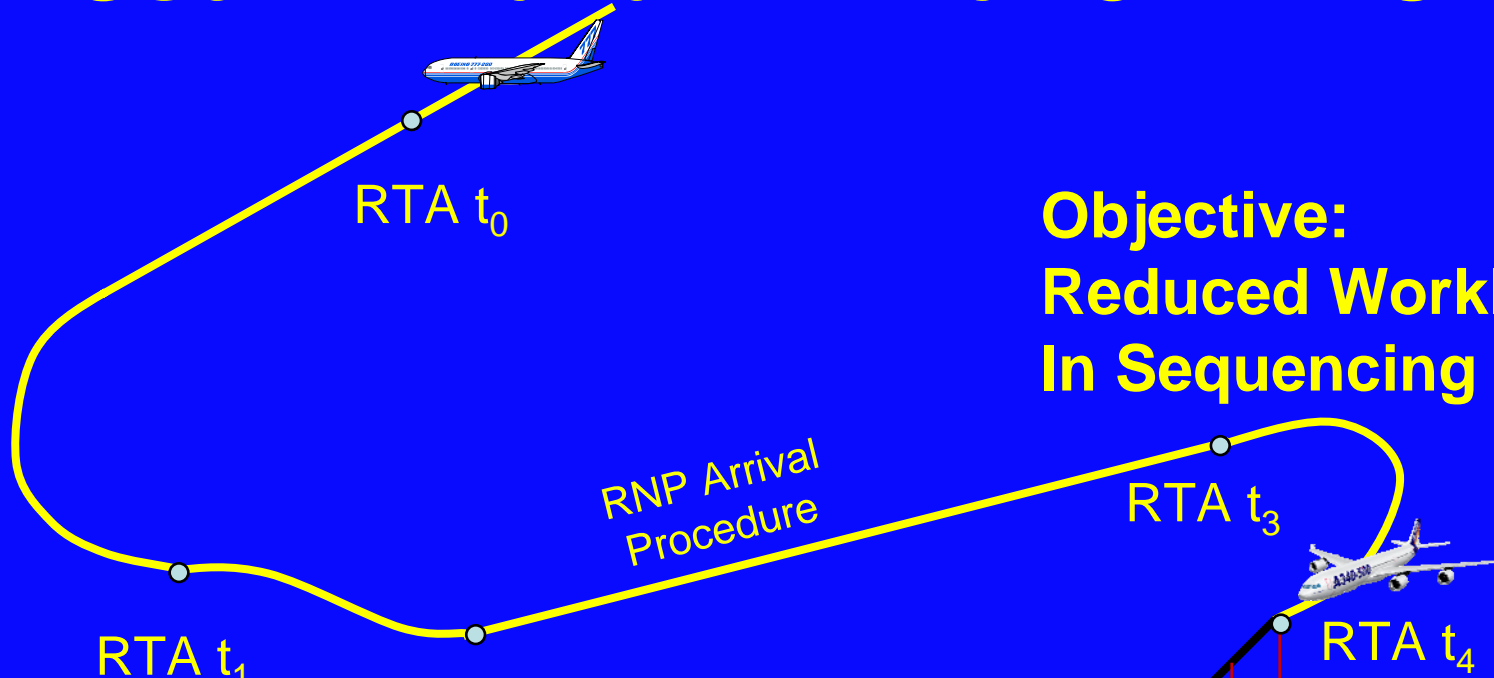


Future RNP Magic En Route



**En Route Procedural Separation can be to 4 miles
Less than current 5 mile radar separation**

Use RNP and RTA for CDA ASAP

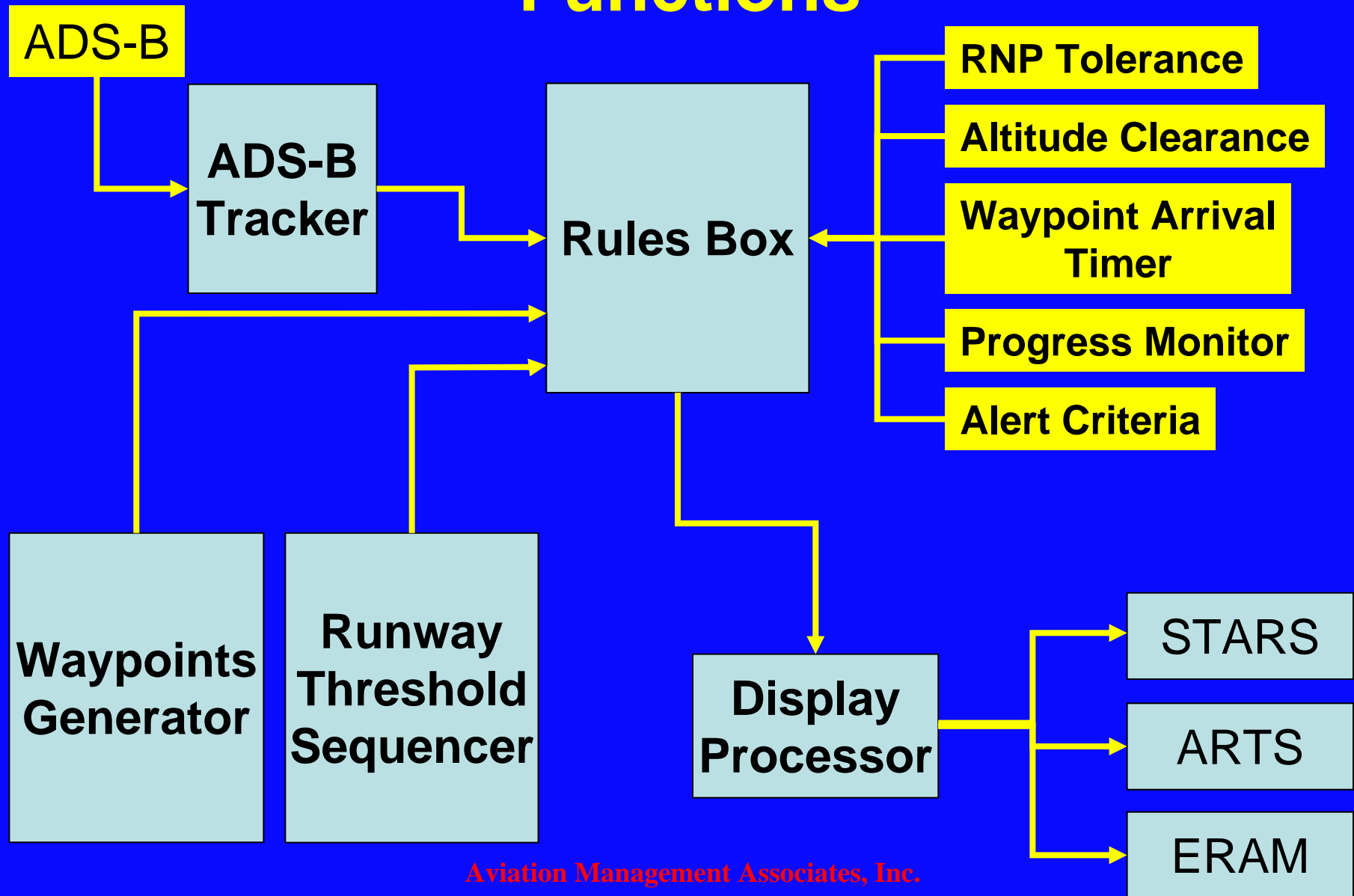


Objective:
Reduced Workload
In Sequencing Arrivals

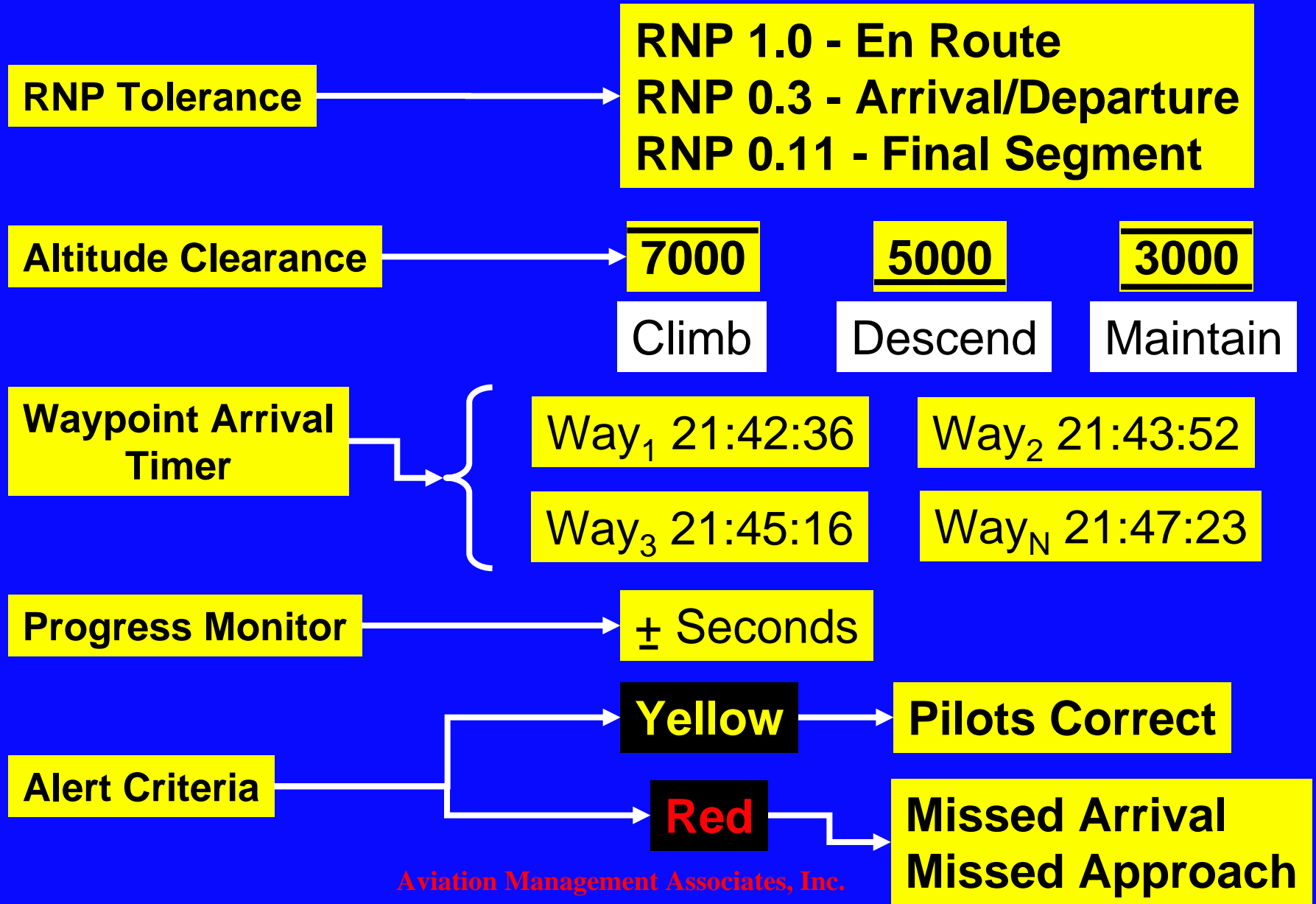
Goal:
Reduce Inter-arrival
Variability and Support
High Volume Continuous
Descent Arrivals

Objective:
Consistent
Time-based
Spacing on
Final Approach

Conformance Operational Concept Functions

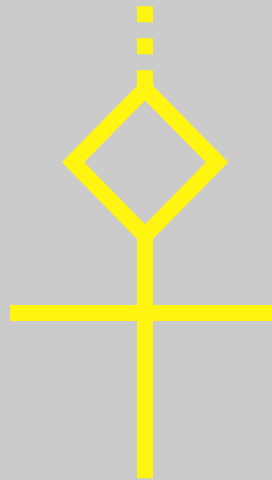


Where The Rules Come From

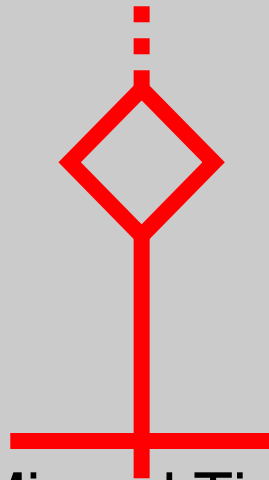




RNAV/RNP



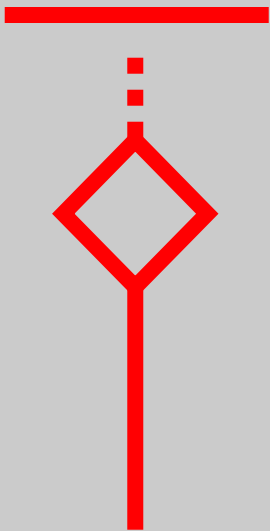
Behind Time



Missed Time
Window



Ahead Time



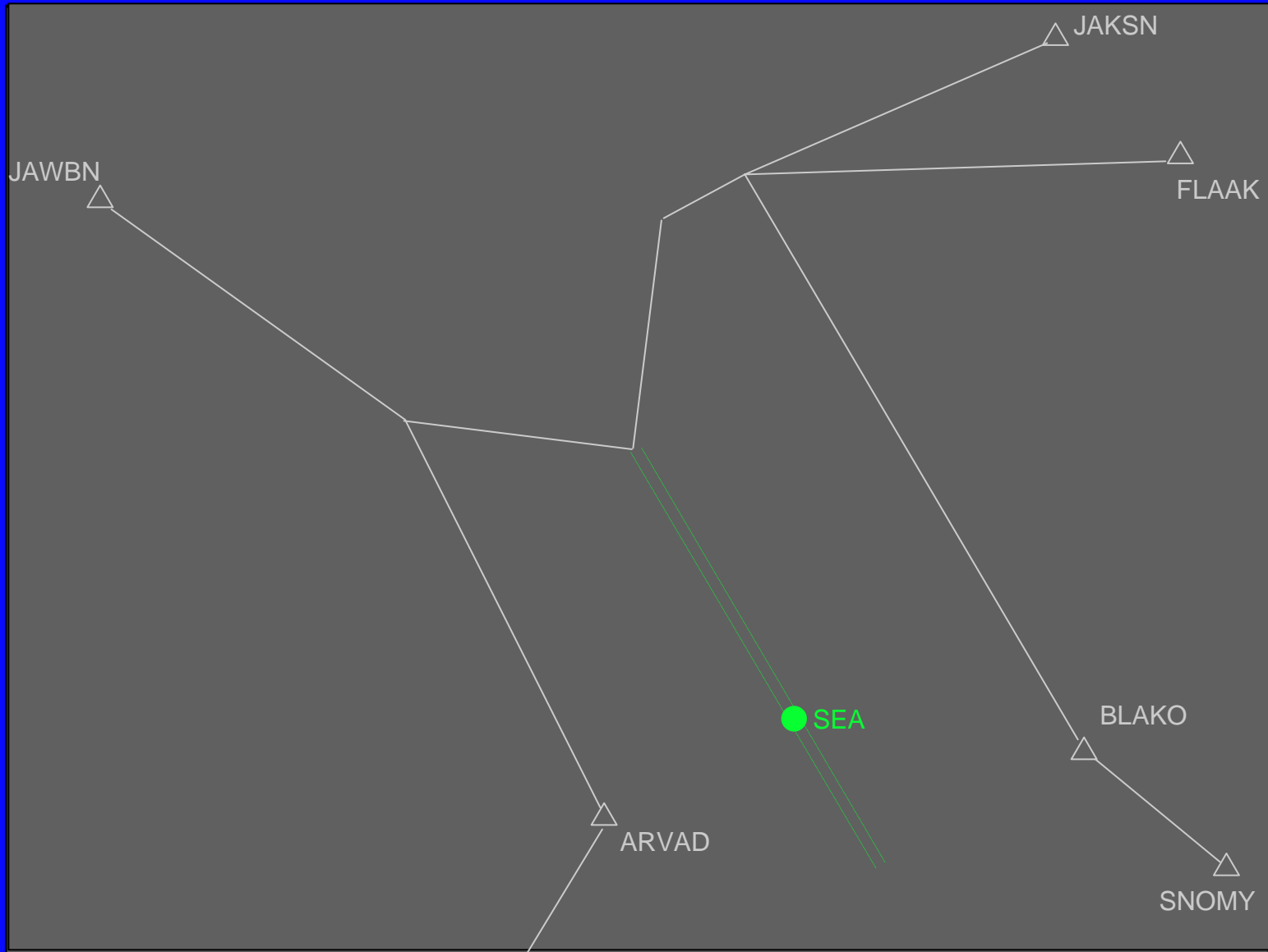
Missed Time
Window



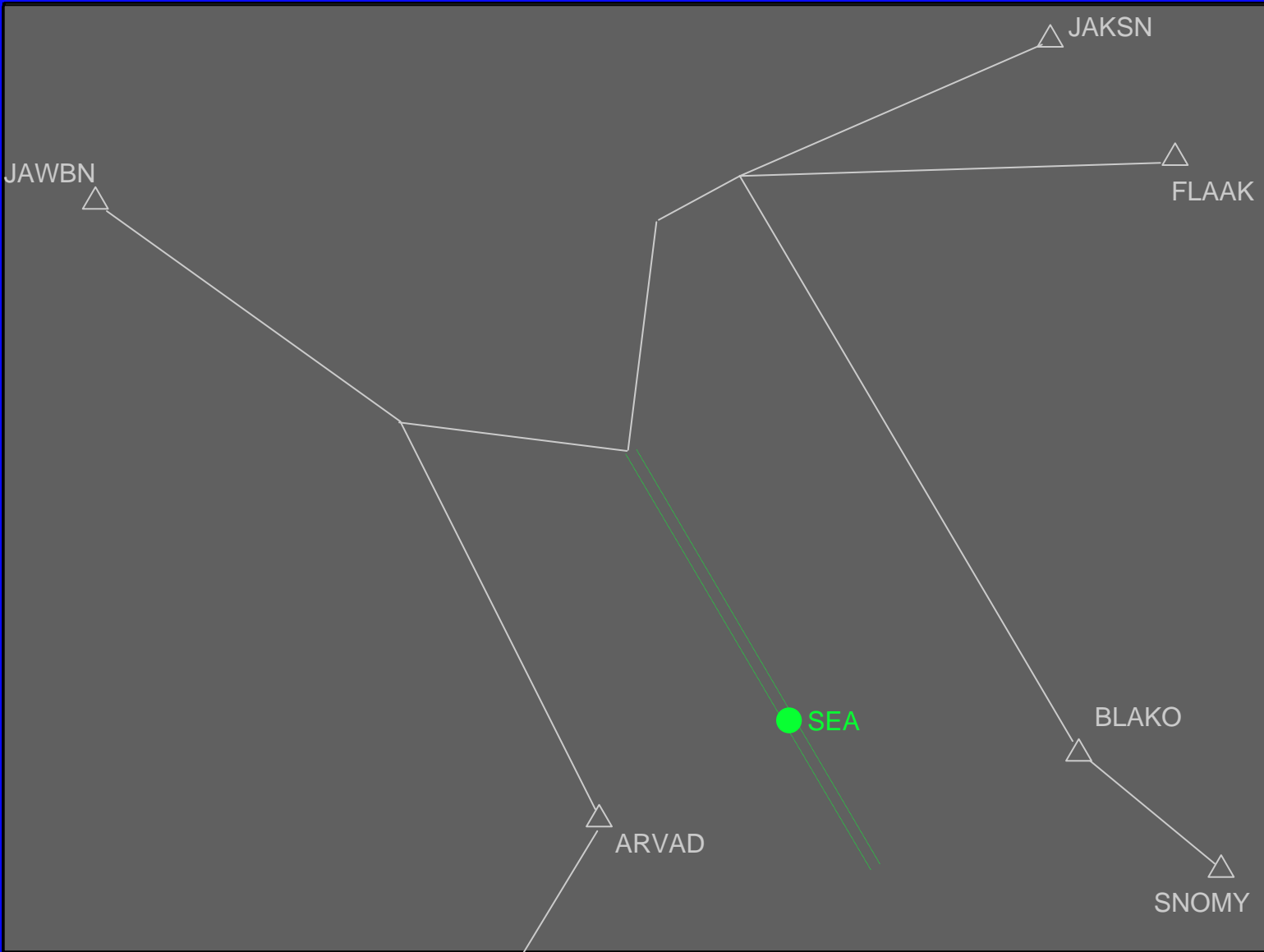
RIGHT
TRACK



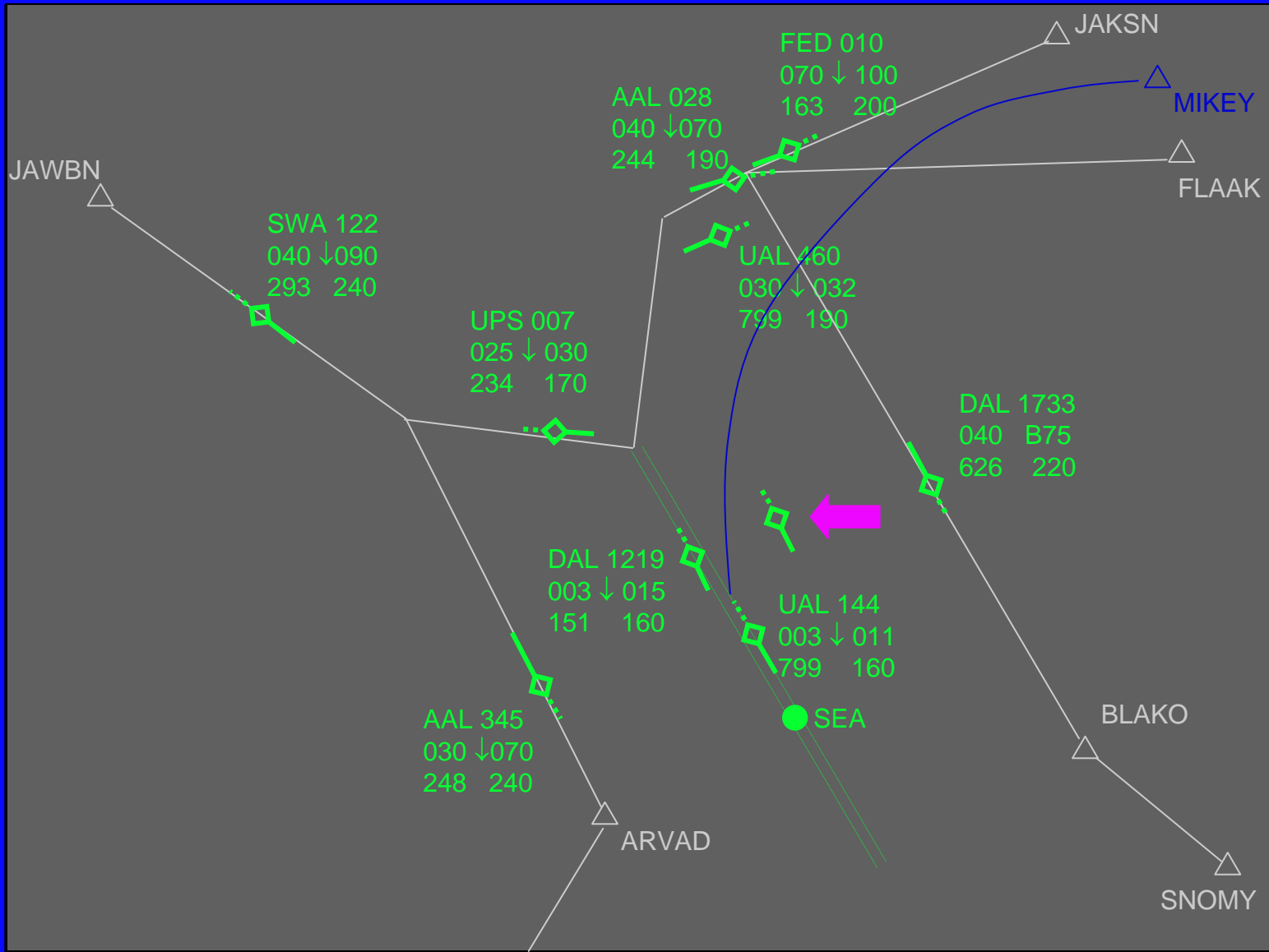
LEFT
TRACK
Vector Required



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Conclusion

- Conformance Monitoring is one operational concept to bridge between today and 4-D
- It uses ADS-B independent of current surveillance and provides controllers a monitor and alert capability
- It provides pilots and controllers a means of increasing continuous descent arrivals
- It helps in the transition by building confidence
- The tools needed create a dynamic waypoint structure, not a published approach
- The tools are based on time at the runway threshold and build on existing sequencing tools

Any Domain Any Airspace

- Starts with continuous descent arrivals
- Can be applied in procedural airspace
- Can be applied en route and along ribbons in the sky connecting city pairs
- Can be used for complex (tight) departures
- Can be used to split existing departure airspace